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WHEAT CULTURE

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The Food Control Bill recently passed by Congress establishes the minimum price of first grade Northern Spring Wheat at two dollars per bushel. This gives the farmer an outlook regarding the demands for wheat, and regarding his share in the sale of this product during the period of the war.

During recent years the acreage of wheat in California has materially declined, partly in favor of barley and other crops and partly because much land that was formerly cultivated has become unprofitable when planted to this crop.

Much has been learned in recent years concerning the diminishing productiveness of wheat lands and in a number of instances the information thus gained has been applied with good results. The application of this information towards the increase in production per acre as well as the extension of the area in wheat may be indicated along the following lines:

Proper and timely preparation of the land for planting.
Importance and methods of maintaining the organic matter in the soil.
Choice of seed respecting both the variety and quality.
Timeliness and manner of planting the crop.
Time, methods, and kinds of fertilization.
Timeliness and methods of harvesting and handling the crop.

Special attention is directed to this presentation of facts, for by studying it one may get a comprehensive notion of the several ways by which the production of wheat may be increased. It is the design of this circular to elaborate these topics and to lay emphasis on the practical bearing of the data in hand.

PREPARATION OF THE LAND

It must be recognized at the outset that most of our grain lands will have to be cultivated under a deficiency of rainfall for the maximum production of crops, hence methods of increasing the moisture holding capacity of the soil and of conserving the moisture when present are of much importance. The usual method employed to attain these ends is to summer fallow. When this is properly carried out good results may be expected.

Time to Plow.—A properly prepared summer fallow accomplishes three purposes—it prepares the land for seasonable planting, it conserves moisture, and it induces the elaboration of available nitrates. Hence, for both annual and biennial cropping, as long a period as possible should intervene between the time of plowing and planting. Ideally the ground should be disked and cross-disked as soon as possible after the removal of the previous crop. This should be followed by plowing to a depth of from five to eight inches, the time depending on the type and condition of the soil. The ground will break up more loosely and easily under this procedure than otherwise and thus give more time for the proper aeration of the soil during the remainder of the season. This plowing should be followed immediately by suitable implements for crushing the clods and pulverizing the surface, for if the soil is left rough little is accomplished in the way of conserving moisture. The danger of leaving the plowing until the winter rains commence is that it may not be done until late in the season and the result will be either poor preparation or too late a planting of the crop.

Depth to Plow.—One reason for the declining yields of wheat in California is that much of the land has either been plowed too shallow or only disked. In some instances this has been the practice for so many consecutive years that the land has lapsed into poor physical condition accompanied by a plow sole and poor drainage. Most California grain lands have no unproductive subsoil within reach of the plow, hence with few exceptions deep plowing may be practiced without fear of bringing inert subsoil to the surface. During three years at the University Farm, Davis, plowing eight inches deep as contrasted with four inches resulted in an increase in the yield of wheat of 37.4 per cent.

Deep plowing is the more effective, the earlier it is accomplished. If plowing is delayed until after the middle of December a shallow plowing for that year with thorough surface working will produce better results. Deep plowing after the middle of December generally

results in a loose soil that does not have moisture-retaining capacity and a physical condition that is detrimental to root development.

The exact depth to plow will vary with the time and the character of the soil. Dry plowing is more expensive than that done when the soil is in optimum moisture condition and the heavy soils may not be plowed so deeply with the same beneficial results as the lighter ones. General practice has shown that plowing to a depth of about eight inches results in the best returns per unit of labor expended.

The land should be brought to a smooth, well-pulverized surface as soon after plowing as possible. The making of this surface will usually compact the subsurface to the consistency which is desirable for the uniform and quick germination of the seed when planted.

MAINTENANCE OF ORGANIC MATTER

More thorough cultivation usually results in a more rapid depletion of the organic matter in the soil. There results from this an increased amount of available nitrogen in the soil and hence increased crop yields. One may not, therefore, expect to produce crop yields by thorough cultivation without at the same time decreasing the organic matter in the soil. It has been found as the average of a number of tests that the available nitrogen in well-prepared and cultivated fallow was more than 200 per cent greater than that in a rough fallow and more than 50 per cent greater than that in unplowed stubble. It is essential, therefore, under better culture methods to put forth additional efforts in maintaining the organic matter content of the soil. This can be done by applying yard manure or other well-rotted litter to the land in the fall to be turned under, or it may be accomplished by growing a cover crop on the land every second, third, or fourth winter, according to the needs of the land and the costs thereof. It requires moisture to rot vegetable material as well as to grow crops. Hence, where moisture is a limiting factor, one must exercise caution in plowing into the soil dry unrotted vegetable material.

Cover Crops.—On the whole the use of cover crops is most advantageous and is perhaps cheapest in the long run. This experiment station has already conducted experiments sufficiently diversified regarding time and soil to show that the yield of wheat is oftentimes more than doubled by the use of cover crops.

The procedure in this operation is briefly as follows: The land is prepared in the fall as for a good summer fallow. As soon as there is sufficient moisture in the soil for quick and uniform germination of the seed the cover crop should be planted. In no case is it advantageous to plant a cover crop later than the middle of December, for under such circumstances the crop would not make sufficient growth to be worth while. Where irrigation is possible, a more satisfactory growth would be obtained by planting before the first of November. This operation should not be delayed, for an abundant growth is desired and this crop should be started early. Horse beans,

fenugreek, Canada field peas, rye and vetch, and vetch and rye each alone have been planted under varying conditions. On the lighter soils rye, and rye and vetch combined seem to do best, while on the heavier soils the horse beans and fenugreek are best. The cover crop should be turned under from eight to ten inches deep before the plants are sufficiently dry to require additional water to rot them. A thorough disking before turning under will facilitate rotting and the soil should be well compacted immediately afterwards in order to get good contact with the green material. The land is then kept in good tilth and free from weeds and planted to wheat the following December. In most instances where organic matter is deficient it is important to furnish quantity as well as quality. As stated above, this procedure may be repeated every third or fourth winter and included as a part of the summer fallowing as the conditions seem to require. By using a cover crop in the system of wheat-growing it is possible in some instances to postpone the summer fallow to the third or fourth year of the cycle. It is safe to say that the cumulative yield over five to eight years will exceed the total yield of continuously cropped land and pay for the cover crop in addition.

GOOD SEED

Varieties.—Excellent preparation of the soil and an optimum organic matter content, however, are no complete assurances of the largest yields possible. It still remains to secure good seed. Two qualities characterize good seed wheat, viz., adaptability and productiveness, assuming of course that the variety has reasonably good milling qualities. In the final analysis of the question the best variety for any farmer to grow is a local problem; for local climate, soil, and culture methods bear more directly on yields for a series of years than do other factors. Therefore, every farmer ought to grow several varieties, some of them on a small scale, until he has ascertained the best for his own conditions. The following list shows those varieties which have good milling qualities and which have for a series of years given good yields at the University Farm:

Variety	Years trial	Yield, lbs. per acre
Propo	6	2911.26
Kings Early	8	2855.4
Early Baart	6	2486.4
Defiance	5	2448.6
White Australian	8	2433.6
Cumberland	6	2346.6
University Gem	4	2134.2
Galgalos	6	2070.0
Federation	5	1953.6

In the following list are indicated the varieties that do well in the respective counties. It is not stated that other varieties would not do well, but where there is any doubt about a variety, those indicated will yield as well as any:

Best wheats for California:

Santa Barbara, Ventura, Los Angeles, Orange, San Diego	Coast, Defiance; interior, Sonora.
Imperial (irrigated)	Bobs, White Australian, Sonora.
Riverside, San Bernardino, Kern, Tulare, Kings	Sonora
San Luis Obispo, Monterey, San Benito	Propo, Galgalos.
Fresno, Madera, Merced, Stanislaus, San Joaquin	Early planting, White Australian. Late planting, Early Baart, Sonora.
Solano, Sacramento, Yolo, Sutter, Yuba, Colusa, Butte, Glenn, Tehama	White Australian, Little Club, Early Baart.
Modoc, Lassen, Siskiyou	Fall seeding, Turkey. Spring seeding, White Australian, Galgalos, California Gem.

The productiveness of good seed wheat depends upon a number of conditions. It should be clean and free from weed seeds, it should be large and plump, and it should be selected only from those fields where conditions of growth and development are best. Farmers sometimes complain that seed wheat runs out or becomes unproductive. This may be the case when no attention is paid to maintaining its good qualities by selection and grading. When properly grown, selected and graded, home-grown seed wheat is, for a series of years, most productive. The advantage in yield from planting large, heavy seed ranges sometimes as high as 20 per cent when compared with the crop from small, light seed. Every wheat farmer should select those portions of his fields which produce, all things considered, the best crop.

The threshed grain should be thoroughly recleaned by means of an ordinary fanning mill prior to seeding. The matter of seed selection can be carried out farther than this, but this method will bring good results and can be carried out on practically every farm.

Smut.—Seed wheat should also be free from smut, or if smut spores be present it should be treated so as to prevent the development of the disease. Losses as high as 15 per cent are sometimes caused by this disease, but by proper treatment these losses may be reduced to almost nothing. Either of two methods may be employed, as follows:

A. *Formalin Method.*—Make a solution of 40 per cent formalin, one pound to forty gallons of water. The wheat may be dipped into this solution in bags or wire baskets for a period of ten minutes, and then spread in the shade to dry. If large quantities are to be treated it is both handy and effective to pile the grain and sprinkle or spray the solution upon it until every grain is wet. Thoroughly wetting every grain is very important, and this may be facilitated by stirring the pile with a shovel or rake as the spraying continues. After thoroughly spraying, it may be spread in the shade to dry.

B. *Copper Sulphate Method.*—The solution for this method is made by dissolving one pound of copper sulphate in four gallons of water. The procedure and time of treatment is the same as for the formalin method.

PLANTING THE CROP

Time of Seeding.—A survey of the wheat conditions in both the great valleys this year emphasized the importance of timely planting. In practically all instances where a wheat crop was poor the reason was found to be improper preparation of the land, or late planting. Even where the rainfall was not up to normal and the season was cold, crops were good where the preparation of the land was good and planting timely. Barring a few exceptional conditions the best crops of wheat are produced from plantings made about December 1. If planted late in December or later the crop will not have sufficient time to develop its roots and crown before growing weather comes in the spring and its ripening will be delayed beyond the period of optimum moisture and climatic conditions.

The following figures show the influence of the time of seeding on the yield of wheat at the University Farm, 1917. The land was prepared the same in both trials. The figures represent the average of three plots for each of the two varieties.

YIELD, POUNDS PER ACRE

Variety	Seeded Dec. 15	Seeded Jan. 19	Seeded Mar. 3
Defiance	3754	1467	1508
Sonora	3825	1742	1178

Sometimes wheat may be planted in the dry soil before the fall rains set in. The advantage of this practice is, especially on large

areas, in getting the seed in before operations are prevented by the rains. The disadvantages are that more seed per acre is generally required and the stand and growth are not likely to be uniform. All things considered planting is best accomplished by the drill and should be done at a time when there is sufficient moisture in the soil to give the seed an even and quick germination. When the land is weedy, planting should be delayed until after the first rain in order that by harrowing early, germinating weeds may be killed.

Amount of Seed.—The amount of seed to plant depends mainly on two conditions: the amount of rainfall or available moisture, and the condition and productivity of the soil. Where rainfall is decidedly low, say from ten to twelve inches and the soil is unproductive, the rate should be forty to fifty pounds per acre. This amount may be increased to ninety to one hundred pounds where rainfall is above twenty inches and the soil productive and in good condition. The larger amount is especially practicable where the planting is on good summer fallow or following alfalfa, or a cover crop. Where the seed is planted by broadcasting, these amounts should be increased by 15 per cent.

FERTILIZATION

Reference has already been made to depleted yields of wheat on continuously cropped lands. In many instances this is due to improper physical condition of the soil, but sometimes it is due to lack of suitable available plant food. Investigations for several years past indicate that in most instances the trouble arises from a lack of sufficient available nitrates at all times during the season of growth. Fertilizer trials near Stockton this year show that 250 pounds of sulfate of ammonia applied at the time of planting produced a yield of 1764 pounds of wheat per acre compared to 947 pounds of wheat per acre from the adjacent plot untreated. Additional information on this experiment is presented in the following table:

Plot	Treatment	Yield, Lbs. per acre
6	50 lbs. N. from sulphate of ammonia	1764
7	Check	947
9	50 lbs. N. from nitrate of soda	1410
10	Check	1176
19	Check	1069
20	Complete fertilizer with lime	1624
24	Potash and phosphoric acid with organic matter	1507
25	Check	809
	Average of treated plots	1574
	Average of check plots	1000

On a field of sandy soil near Glendale (Los Angeles County) sulphate of ammonia was applied to the growing grain on February 11 at the rate of 200 pounds per acre and the yield of wheat was increased from 822 pounds per acre to 2114 pounds per acre; an

increase of 157 per cent. These are outstanding instances, but they emphasize the fact that, especially on lands that are unproductive because of poor soil, it pays to apply fertilizers containing available nitrogen.

Additional data on this experiment appears in the following table:

	Fertilized	Unfertilized	increase Per cent
Number of head-bearing culms	4680	2387	96.4
Weight of heads, grams	3741	1457.1	156.7
Weighted average length of culms	67.92	58.25	16.6
Sterile spikelets per head	3.35	5.11	52.4*
Average number of grains per head	19.87	16.65	19.3
Weight per 1000 heads, grams	799.3	610.4	30.9
Average weight of grain per head, grams	.5881	.4484	31.1
Weight per 100 grains, grams	31.606	30.105	4.98
Percentage of grain to total weight of culms	.4051	.3847	.53

* Decrease.

The time to apply this fertilizer depends on various conditions, but probably in most instances it should be applied at the time of planting. Where sulfate of ammonia or nitrate of soda is used a portion of this may be applied in late January or early February, especially on those portions of the field that may indicate by the color or growth of the grain the need of additional nitrogen. The importance of proper fertilization is especially emphasized because it is desirable to increase the yield at this time as much as possible.

IRRIGATION

Most wheat in California is grown without irrigation. However, where water is available and the land is adaptable one irrigation may be given during the early growth of the crop, for water is not so much needed for other crops at that time. There are parts of California, especially in the Imperial and southern San Joaquin valleys, and in localities in the northeastern part of the state where wheat may be grown only by irrigation. In irrigating wheat the principal points on which information is desired are the amount of water to use and the times of application. The practice on both of these points will vary according to a number of conditions such as precipitation, soil porosity and depth, and the temperature and dryness of the air which controls evaporation. In general, and especially where irrigation must be depended upon entirely, three irrigations of about five acre-inches each have produced best results. This water should be applied at the five-leaf stage, when the head is in the boot, and at the stage of blossom. Where only one or two irrigations can be given the water should be applied at the first and second periods, respectively.

Germinating and starting wheat by irrigation has not been found a good practice because it leaves the soil in a compact and crusted condition. This condition is not conducive to the subsequent normal development of the plant.